O.I.P.E JC1i2 NOV 26 2004 PATENT & TRADEMARK OFFICE

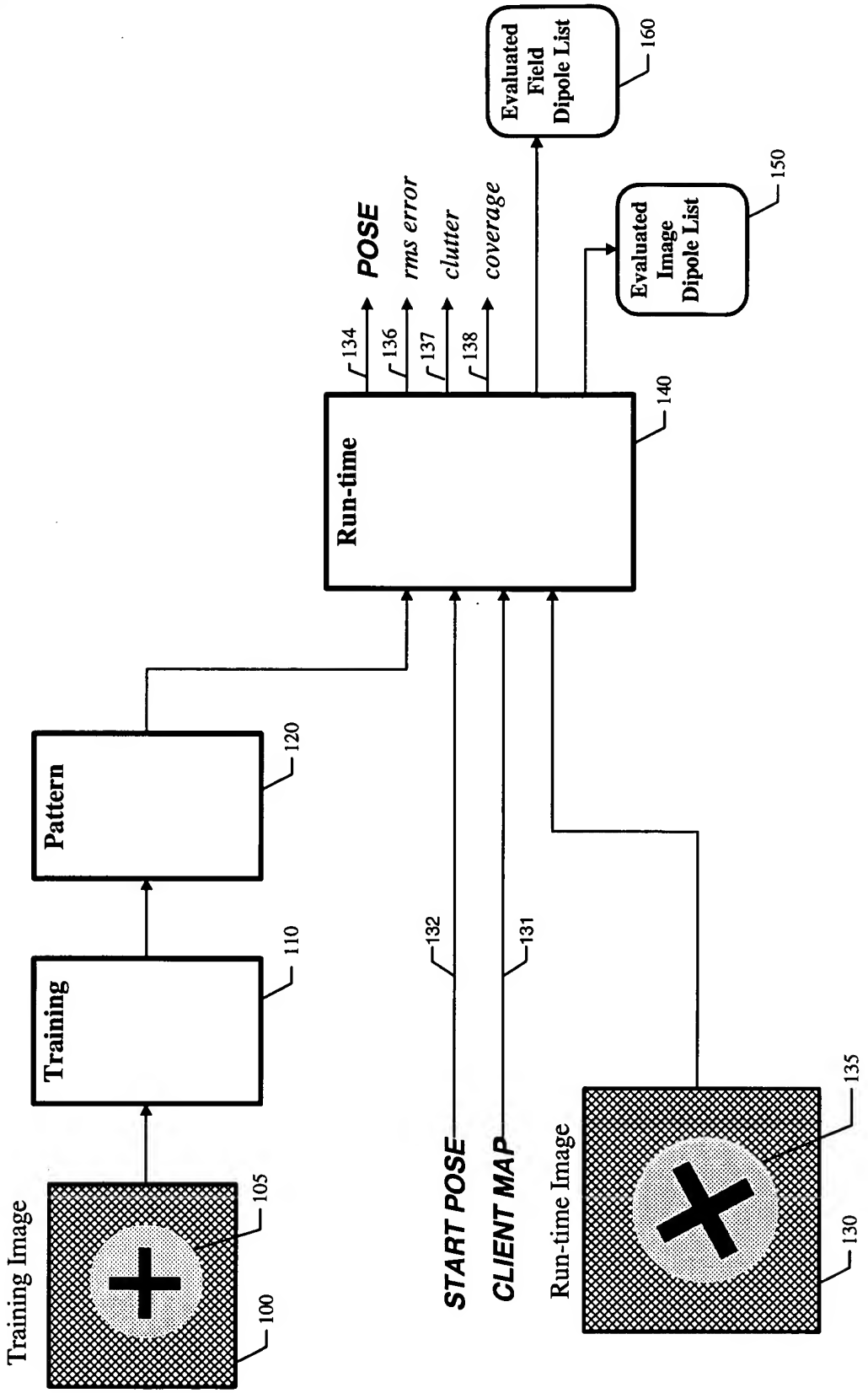

Figure 1

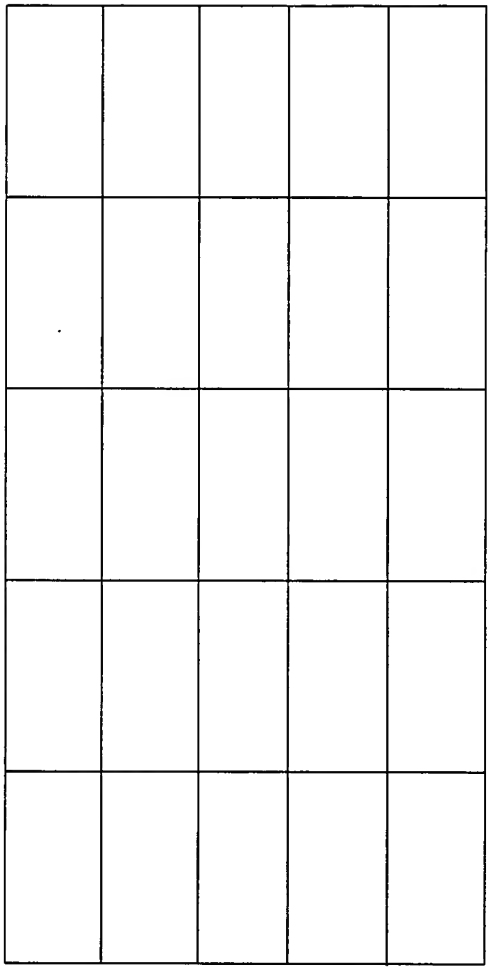

Figure 1A

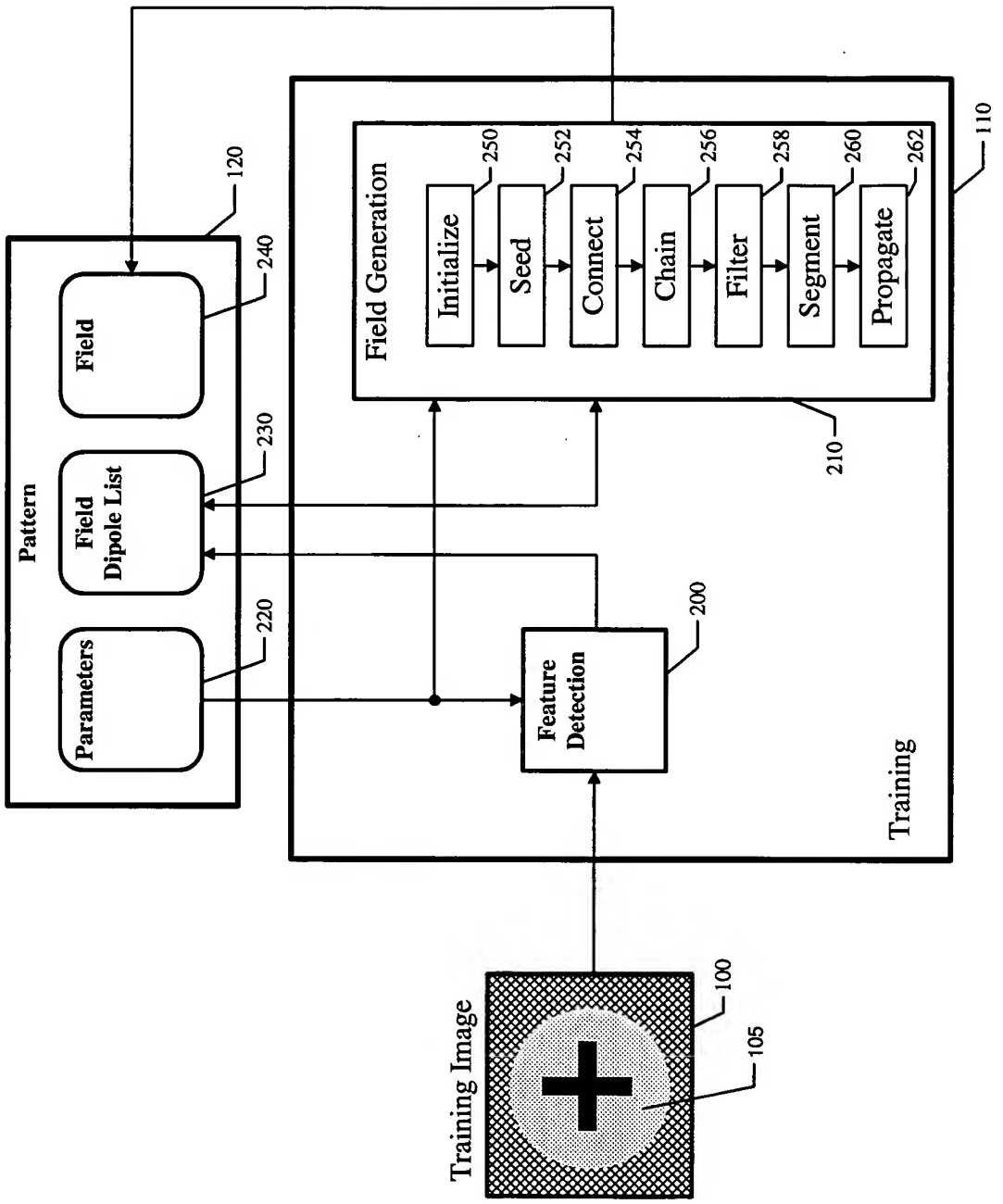
Training Image
100
105
Training
110
Feature Detection
200
Pattern
Parameters
220
Field Dipole List
230
Field
240
120
Field Generation
Initialize
250
Seed
252
Connect
254
Chain
256
Filter
258
Segment
260
Propagate
262
210

Figure 2

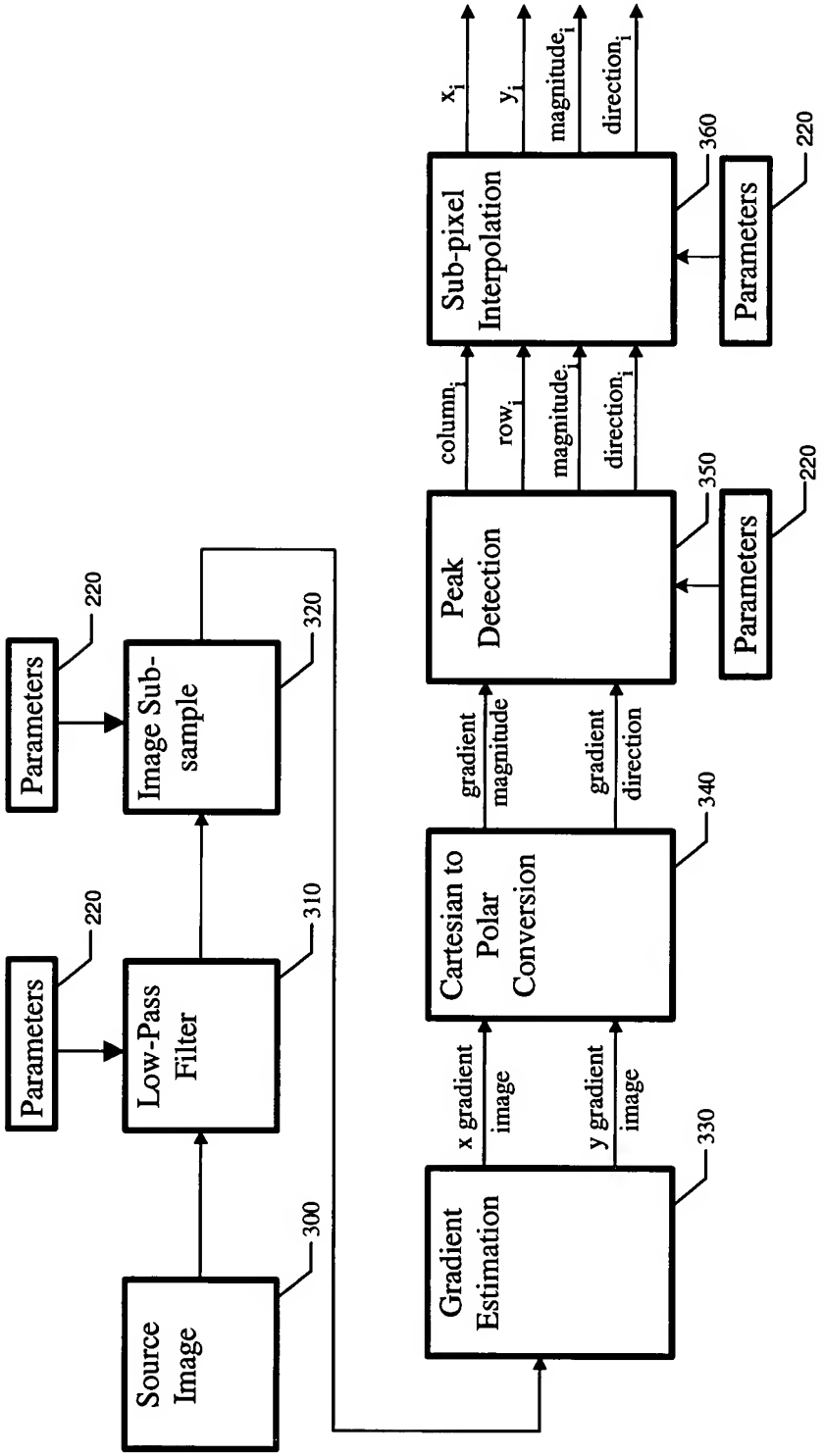
Source Image
300
Parameters
220
Low-Pass Filter
310
Parameters
220
Image Sub-sample
320
Gradient Estimation
330
x gradient image
y gradient image
Cartesian to Polar Conversion
340
gradient magnitude
gradient direction
Peak Detection
350
Parameters
220
column$_i$
row$_i$
magnitude$_i$
direction$_i$
Sub-pixel Interpolation
360
Parameters
220
x_i
y_i
magnitude$_i$
direction$_i$

Figure 3

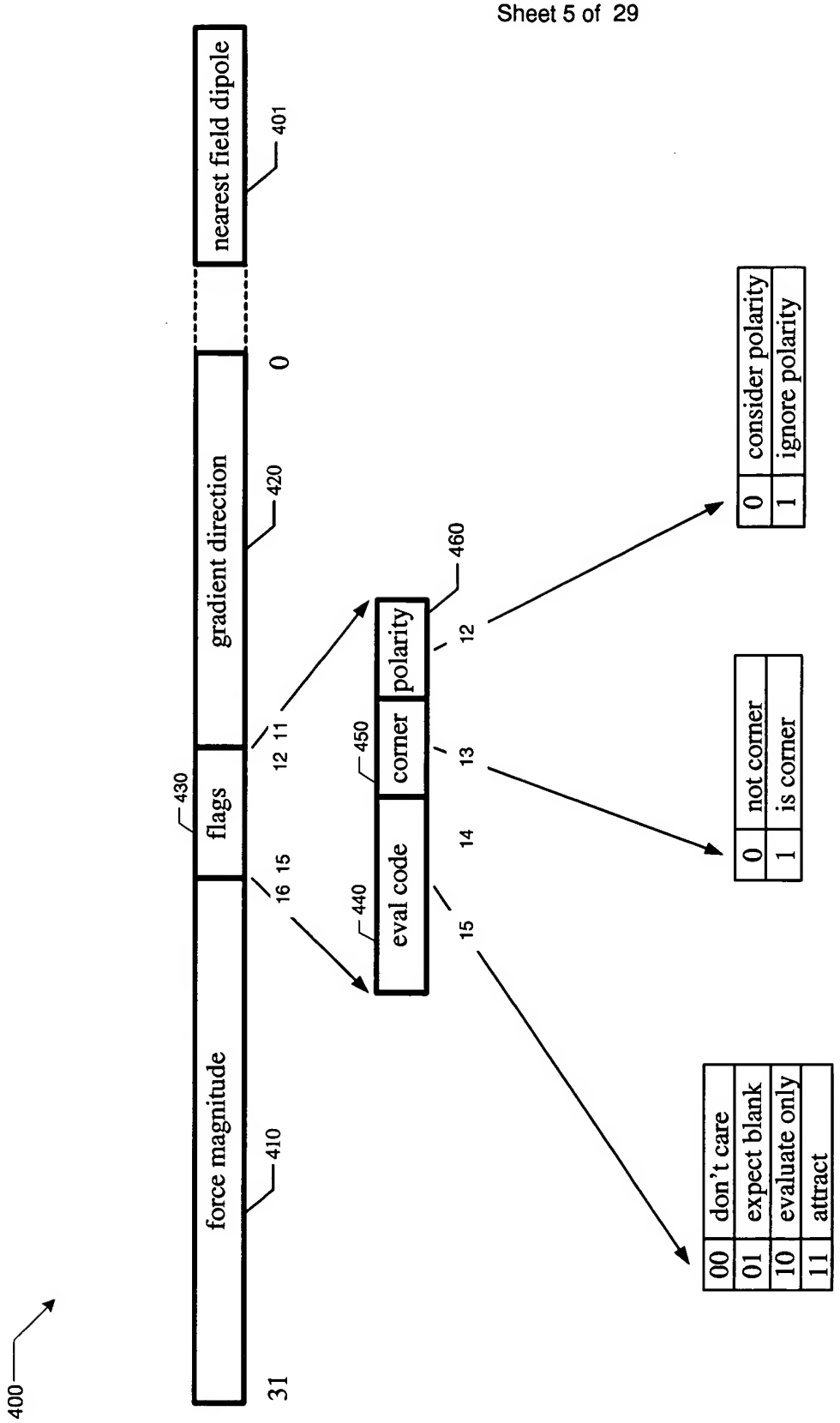
400
31
force magnitude
410
flags
430
gradient direction
420
nearest field dipole
401
0
eval code
440
corner
450
polarity
460
16 15
12 11
15
14
13
12
00 don't care
01 expect blank
10 evaluate only
11 attract
0 not corner
1 is corner
0 consider polarity
1 ignore polarity

Figure 4

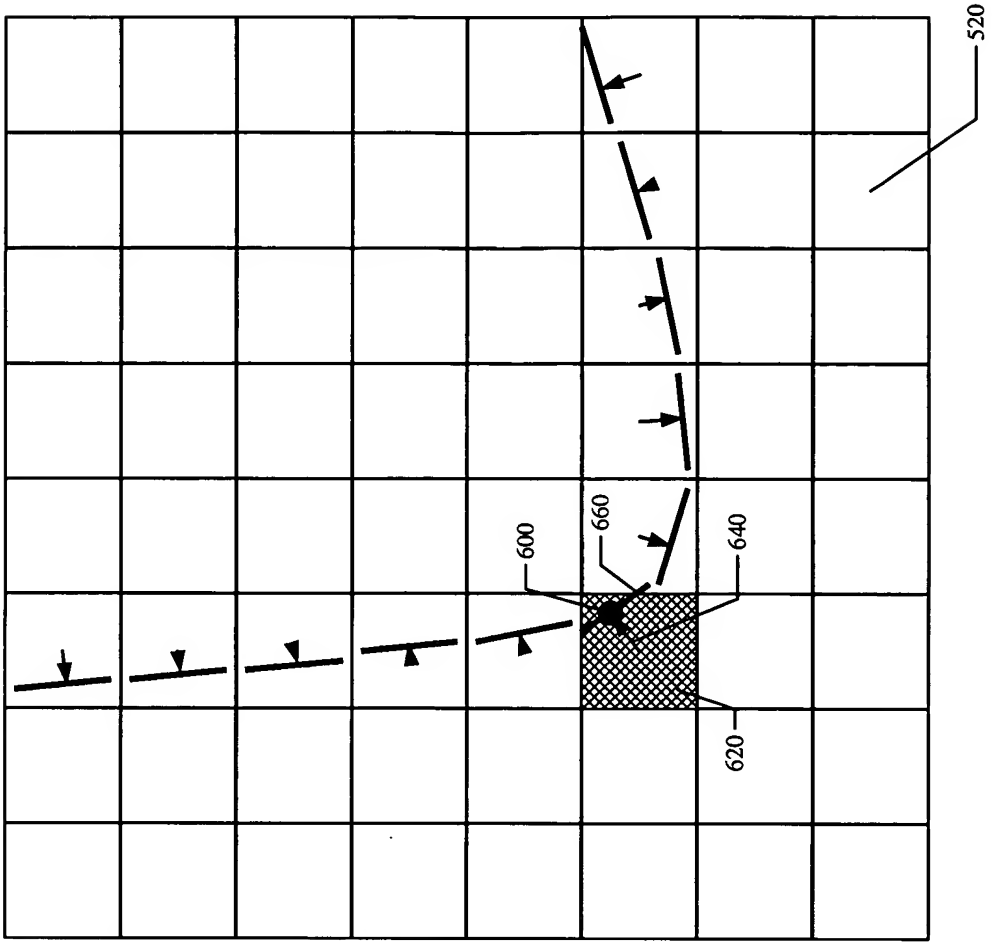

Figure 6

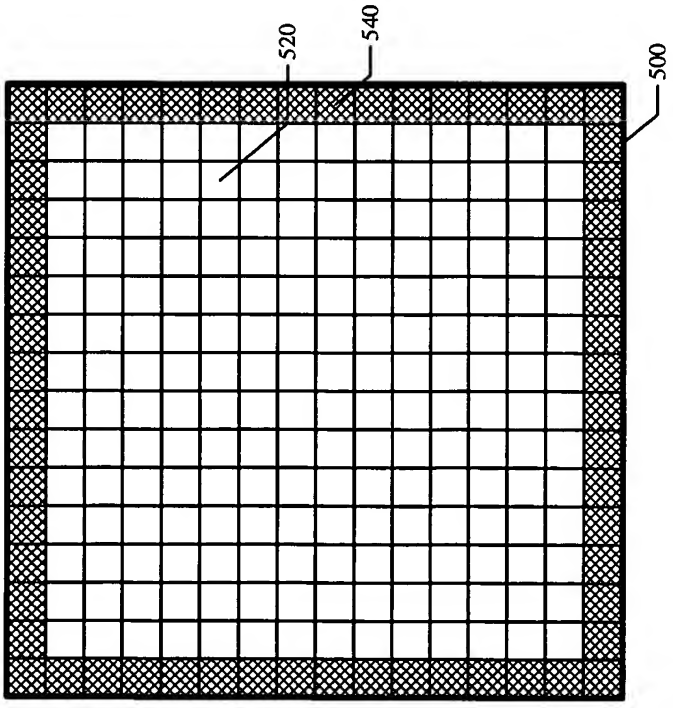

Figure 5

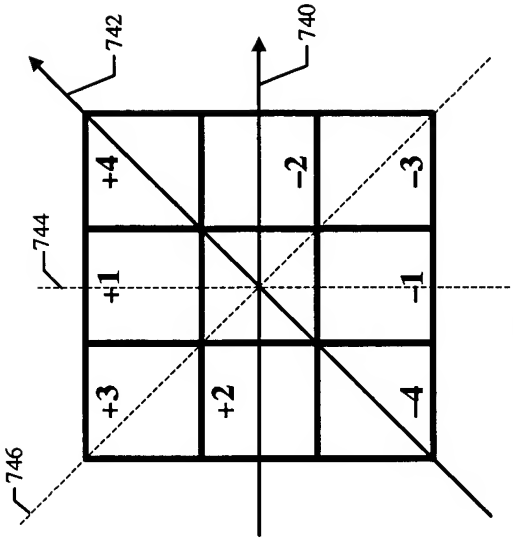

Figure 7b

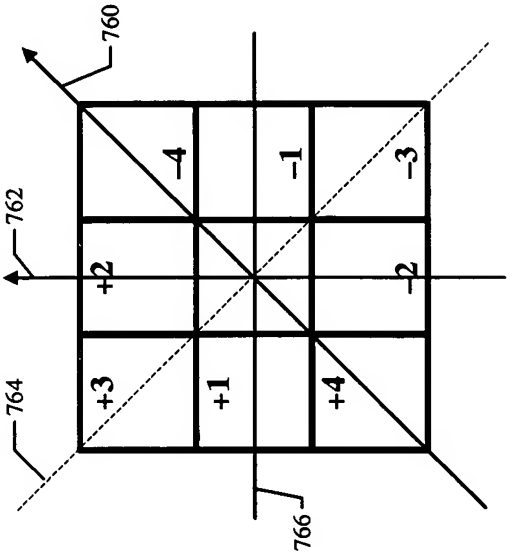

Figure 7c

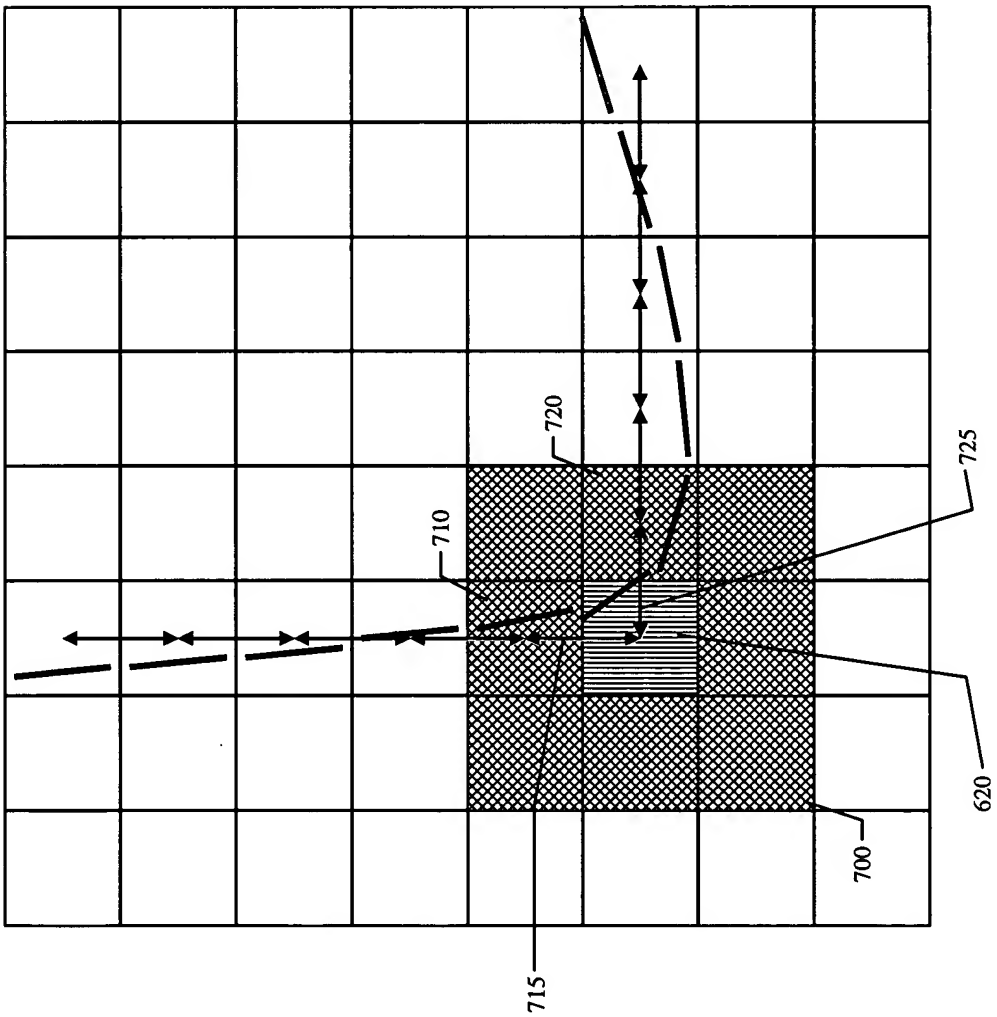

Figure 7a

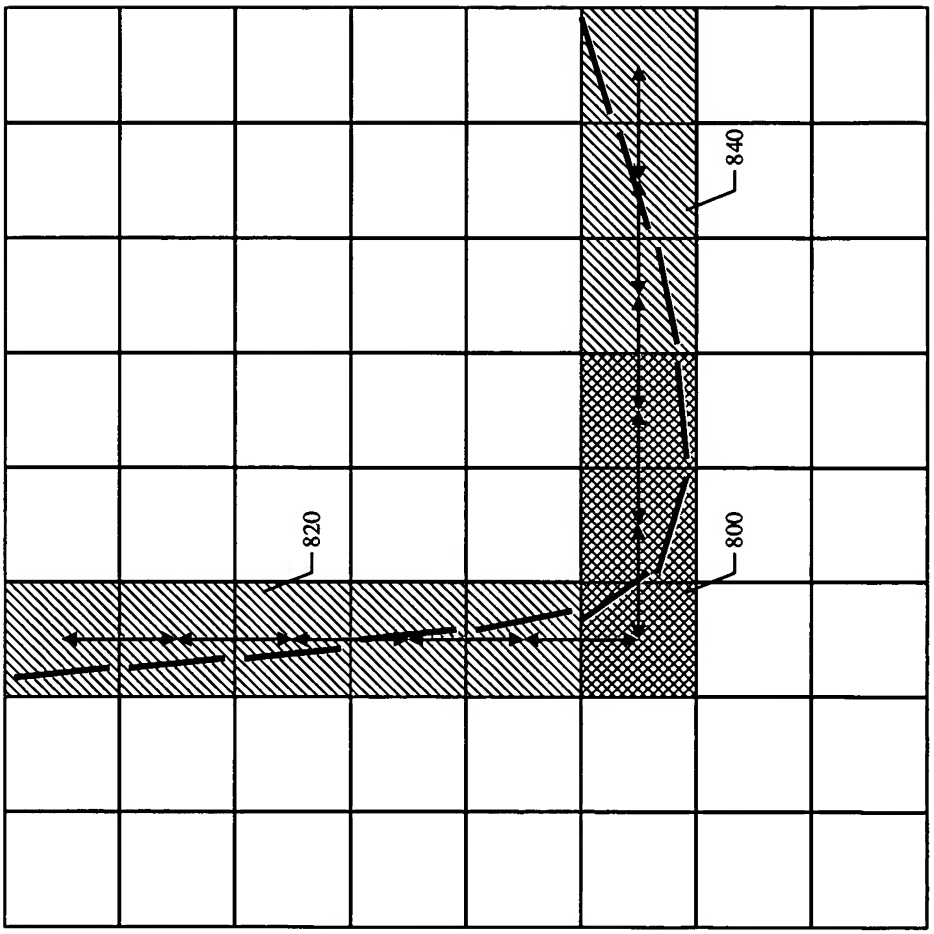

Figure 8

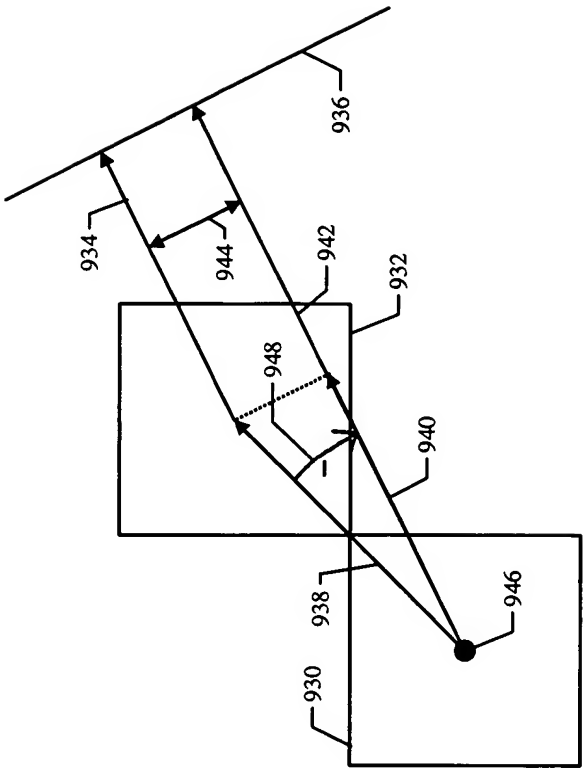

Figure 9b

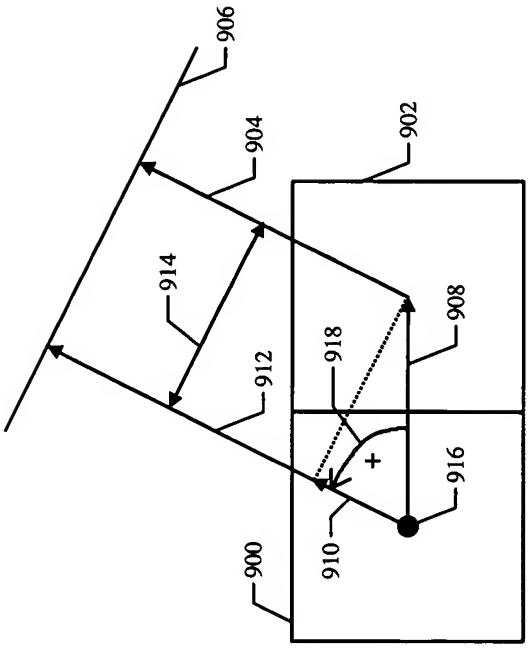

Figure 9a

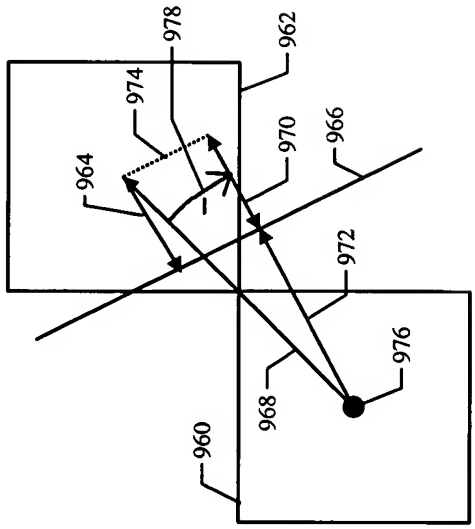

Figure 9c

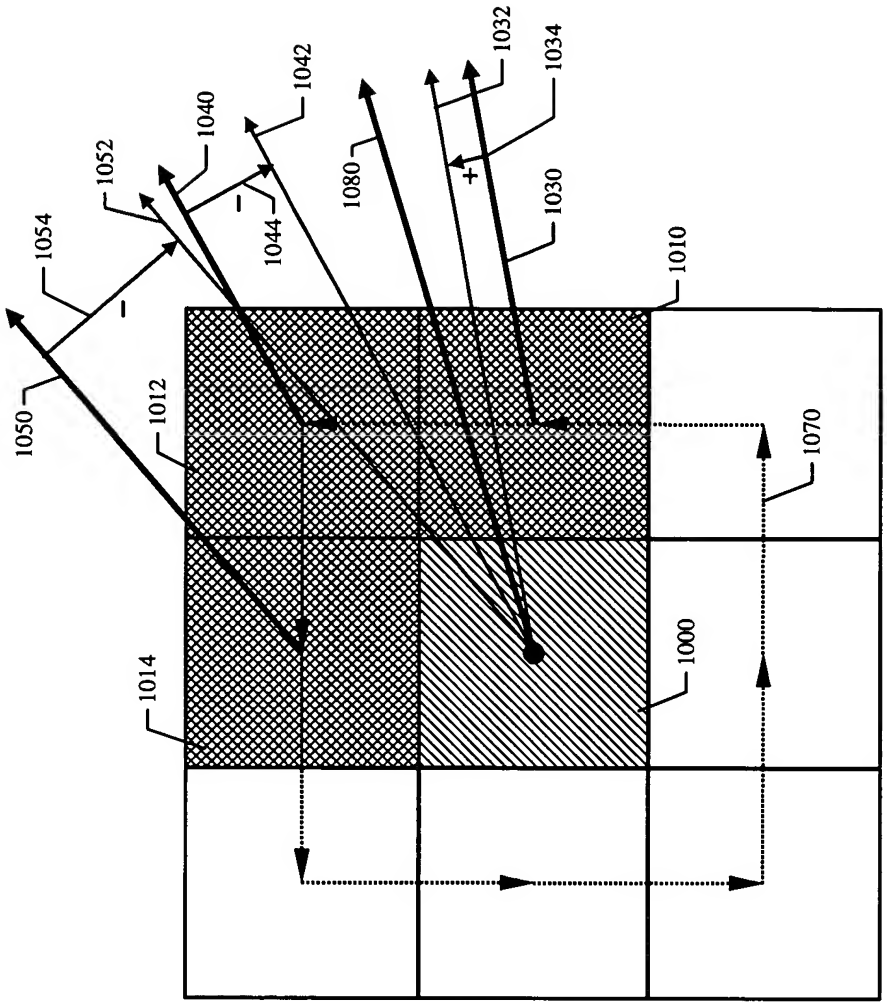
1032
1034
1042
1040
1052
1080
1030
1054
1044
1010
1050
1012
1070
1000
1014

Figure 10

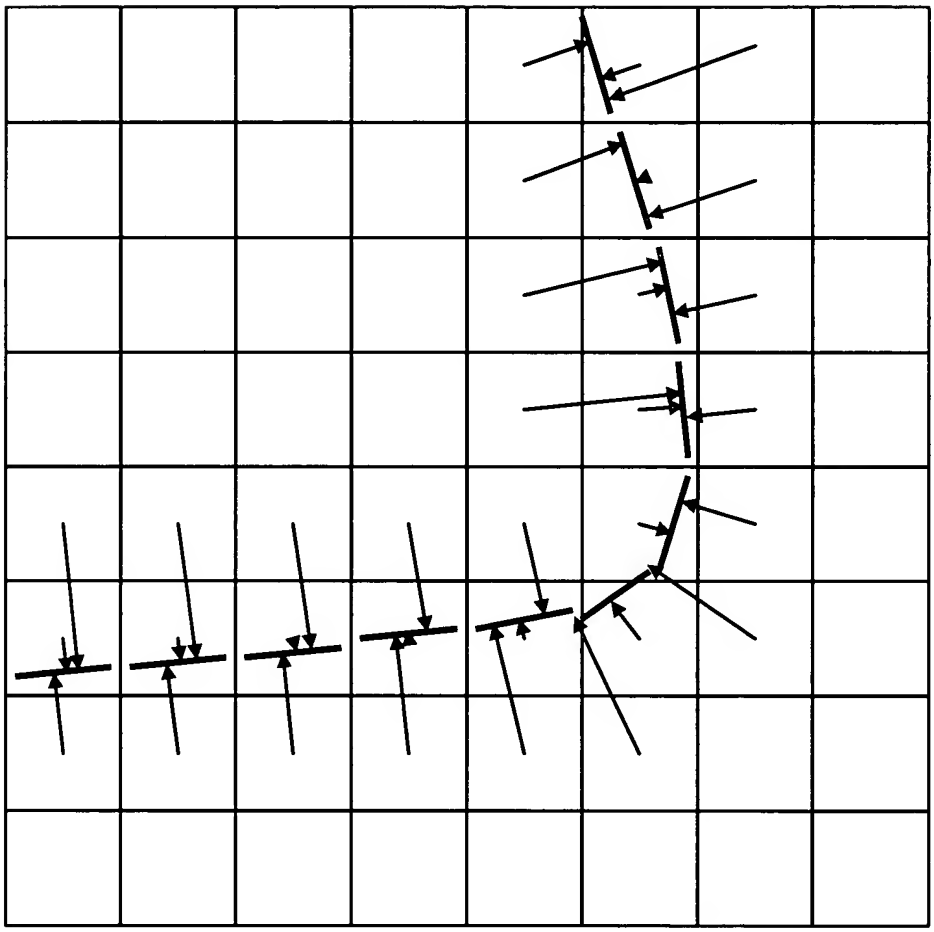

Figure 11

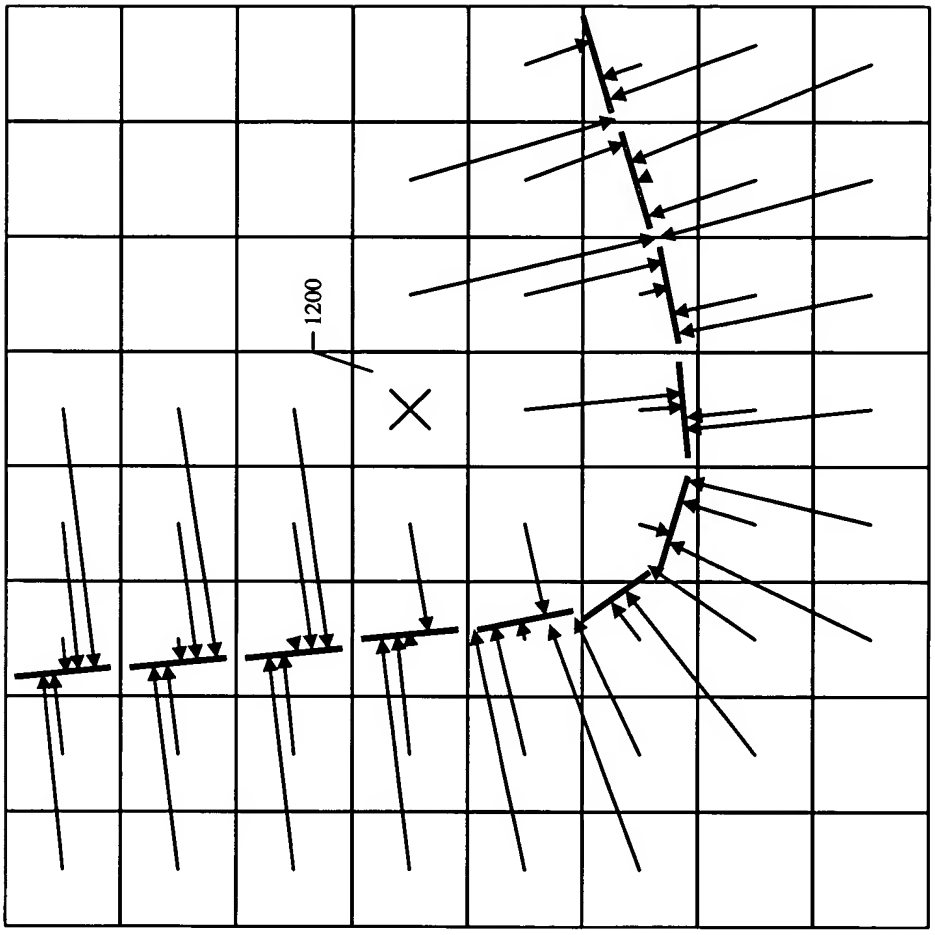

Figure 12

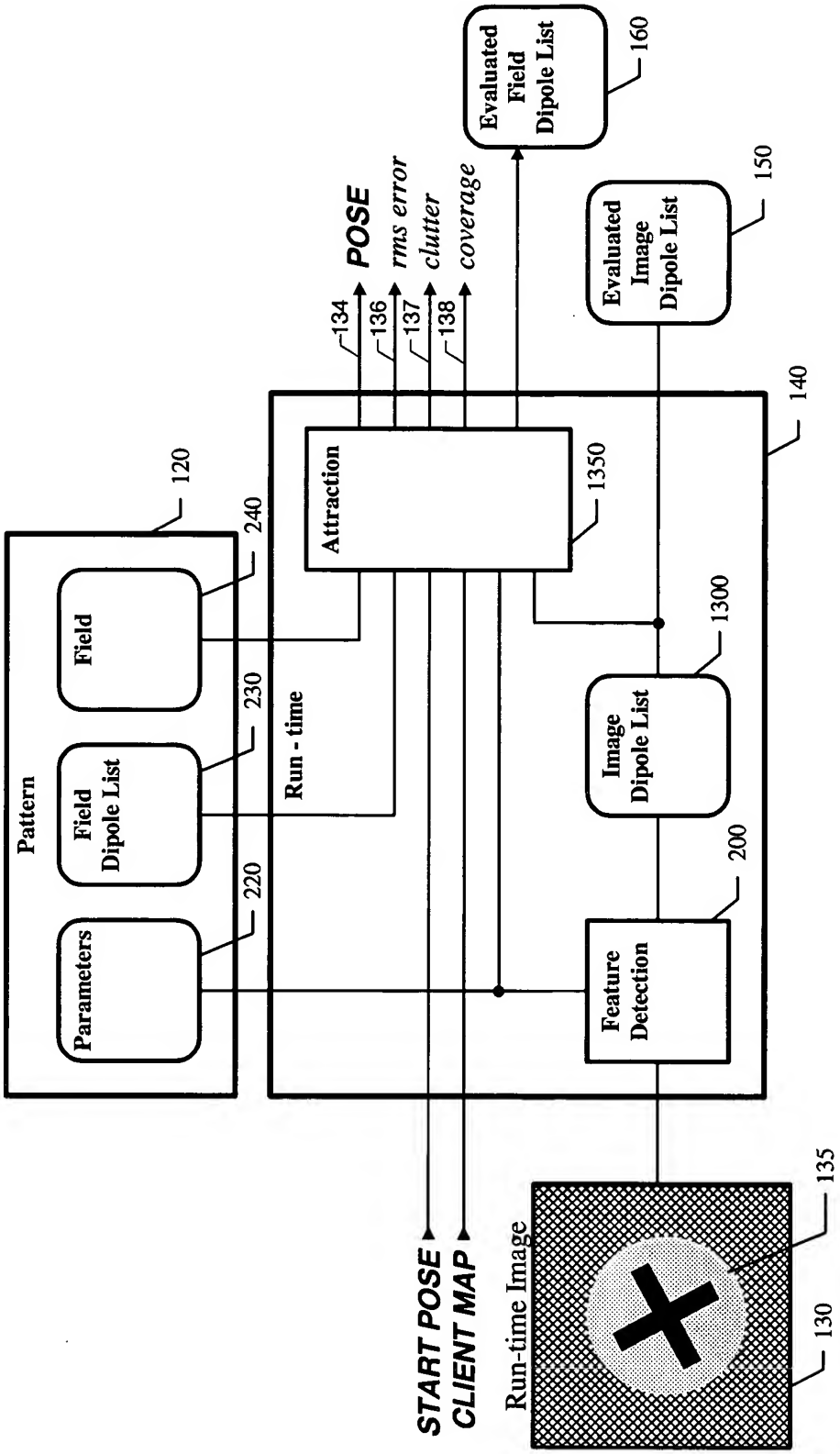
Evaluated Field Dipole List
160
Evaluated Image Dipole List
150
POSE
rms error
clutter
coverage
134
136
137
138
140
Attraction
1350
Pattern
120
Field
240
Field Dipole List
230
Parameters
220
Run - time
Image Dipole List
1300
Feature Detection
200
START POSE
CLIENT MAP
Run-time Image
135
130

Figure 13

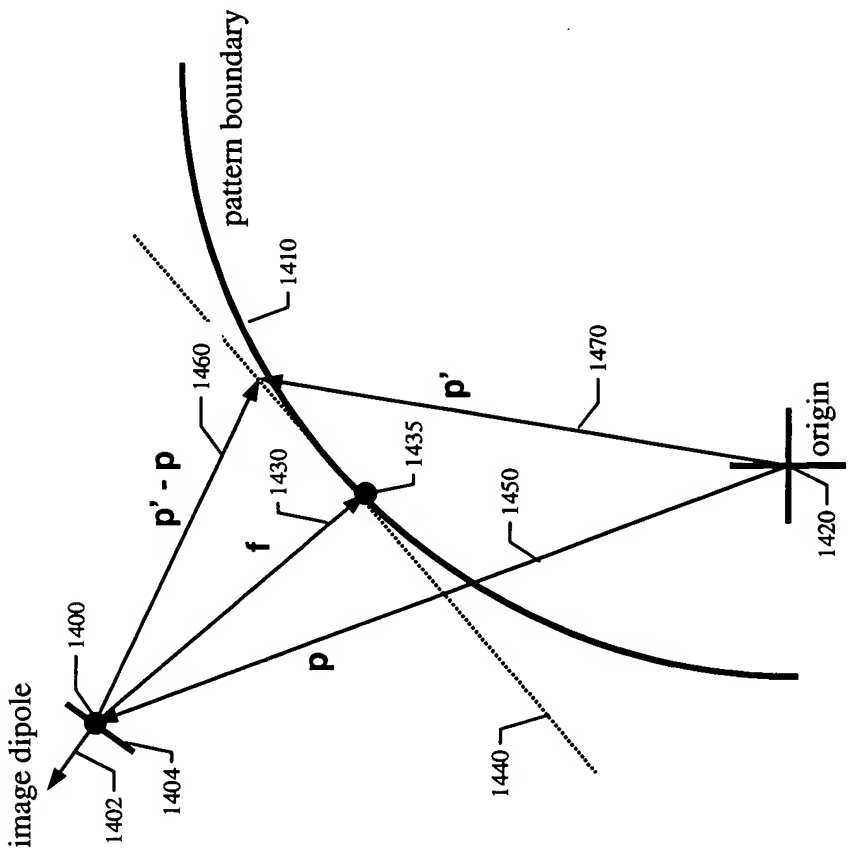
image dipole
1400
1402
1404
pattern boundary
1410
1460
p' - p
1430
f
1435
p
1450
p'
1470
origin
1420
1440

Figure 14

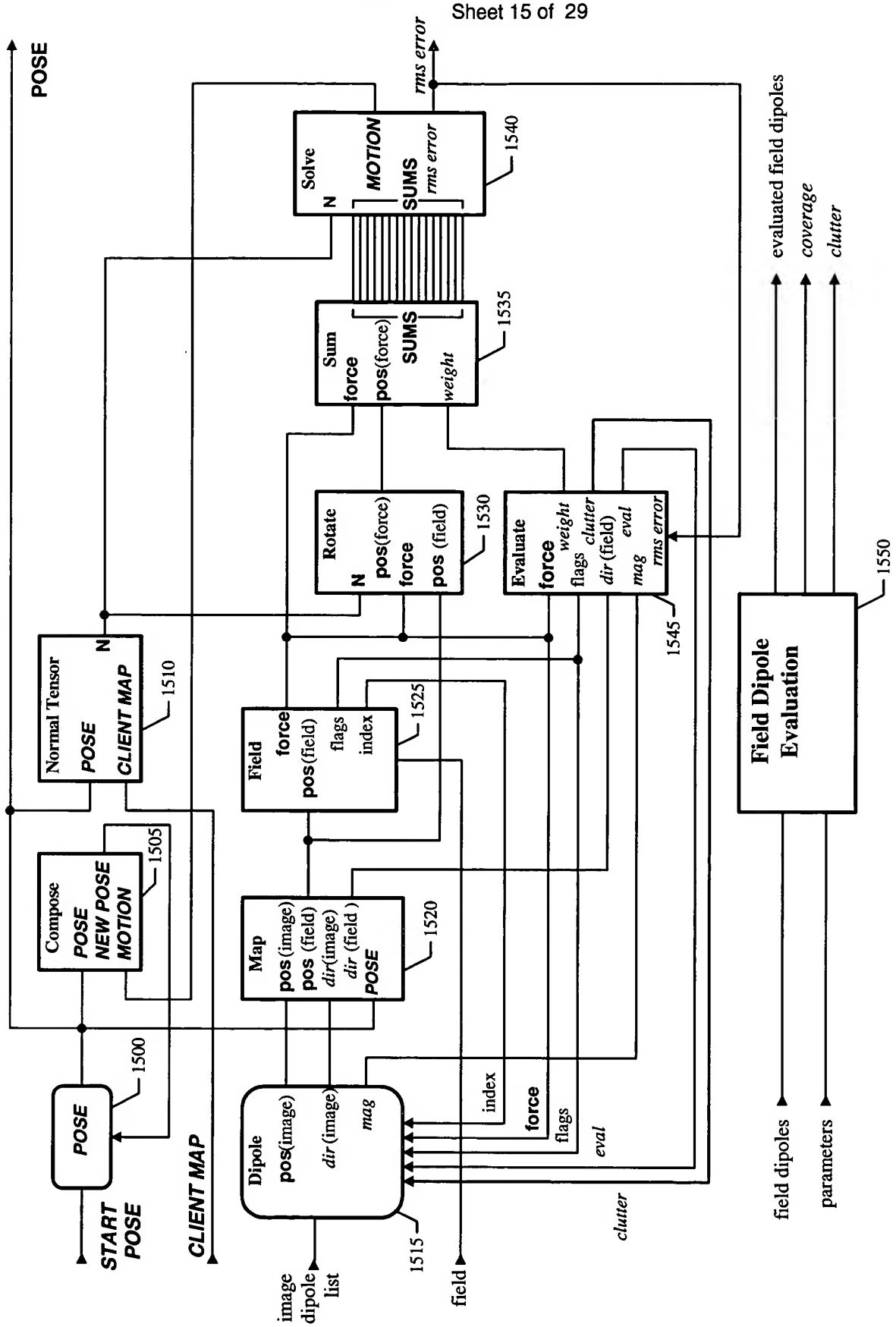
POSE
rms error
Solve
N
MOTION
SUMS
rms error
1540
Sum
force
pos(force)
SUMS
weight
1535
Rotate
N
pos(force)
force
pos (field)
1530
Evaluate
force
weight
flags
clutter
dir (field)
eval
mag
rms error
1545
evaluated field dipoles
coverage
clutter
Field Dipole Evaluation
1550
Normal Tensor
POSE
N
CLIENT MAP
1510
Field
force
pos(field)
flags
index
1525
Compose
POSE
NEW POSE
MOTION
1505
Map
pos (image)
pos (field)
dir(image)
dir (field)
POSE
1520
POSE
1500
START POSE
CLIENT MAP
Dipole
pos(image)
dir (image)
mag
1515
image dipole list
field
index
force
flags
eval
clutter
field dipoles
parameters

Figure 15

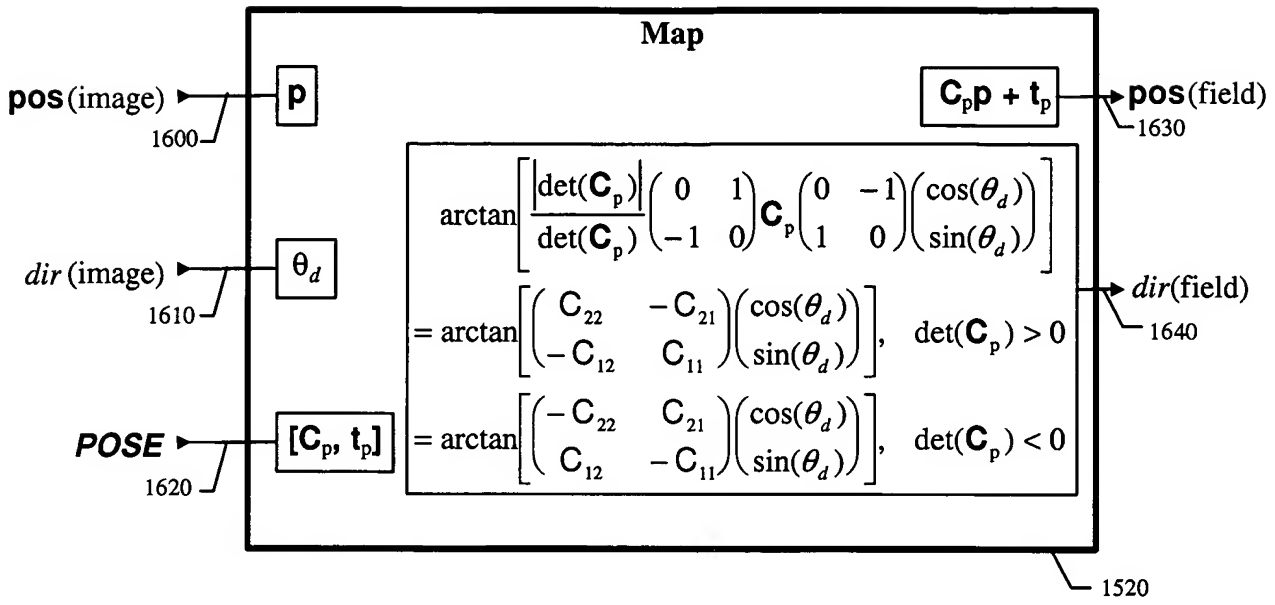

Figure 16

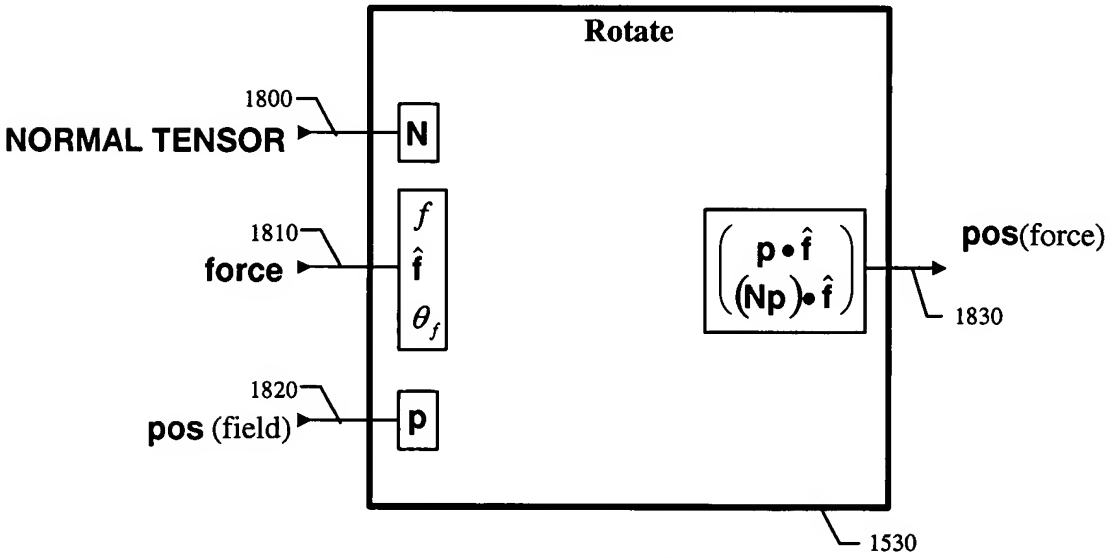

Figure 18

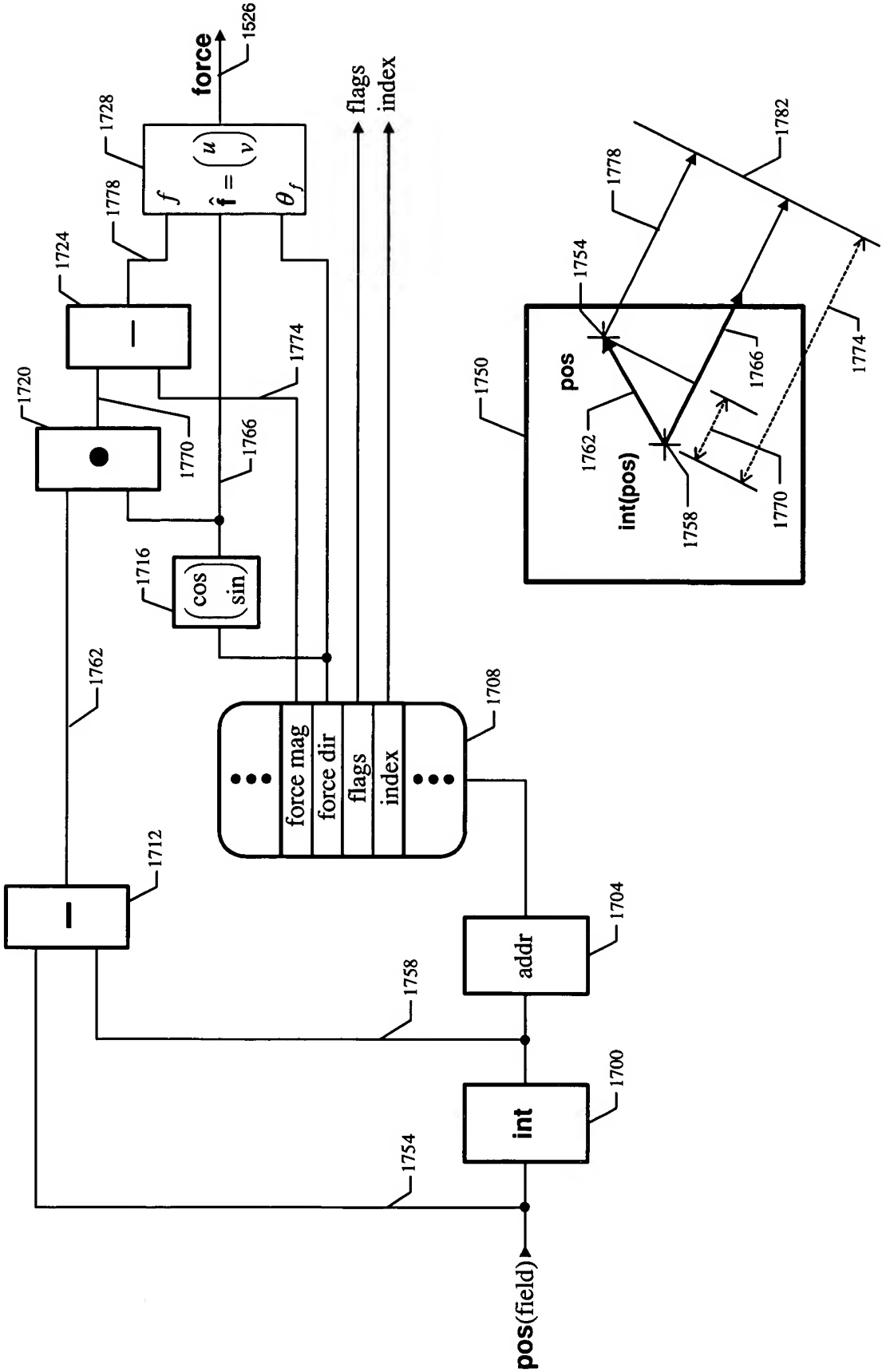
force
1526
flags
index
1728
1778
1724
1720
1774
1770
1766
1716
1762
1708
force mag
force dir
flags
index
1712
1704
addr
1758
1700
int
1754
pos(field)
1782
1778
1754
pos
1762
int(pos)
1758
1766
1770
1774
1750

Figure 17

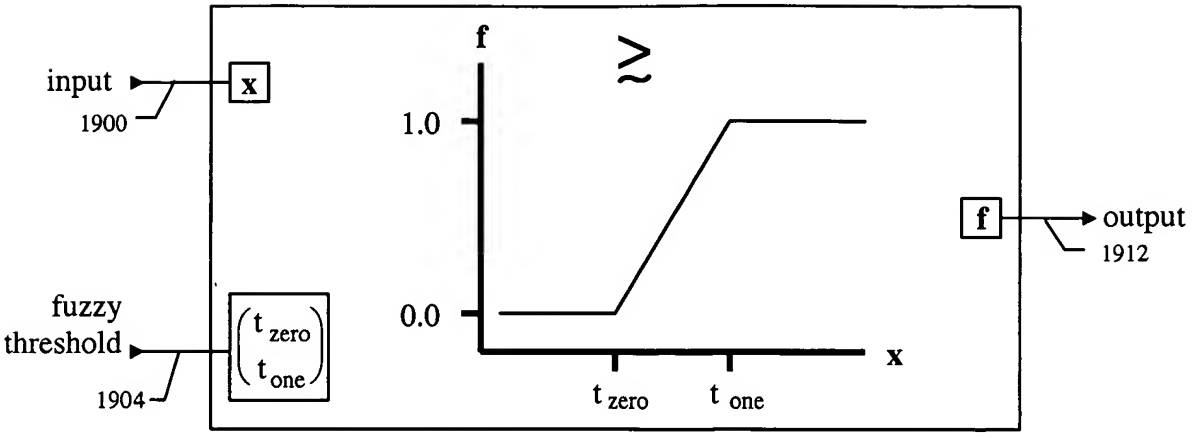

Figure 19a

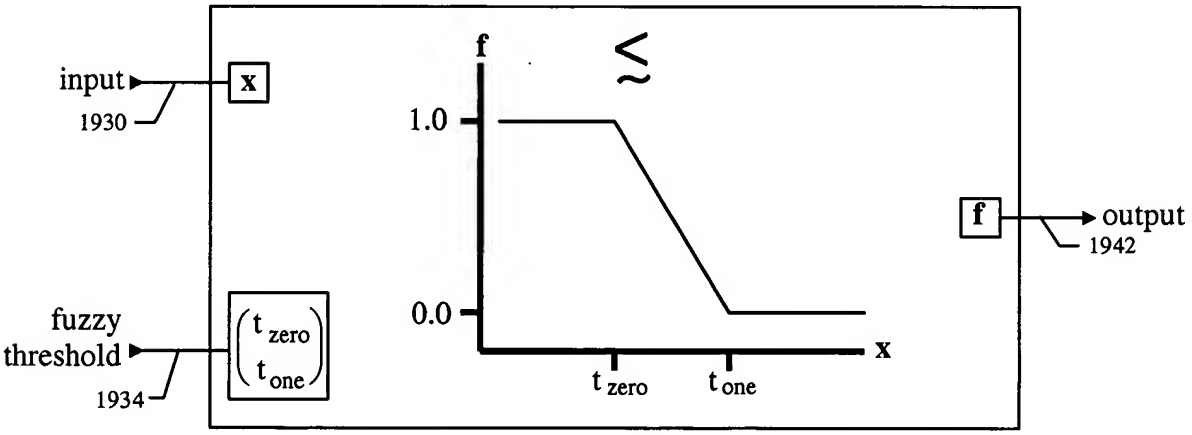

Figure 19b

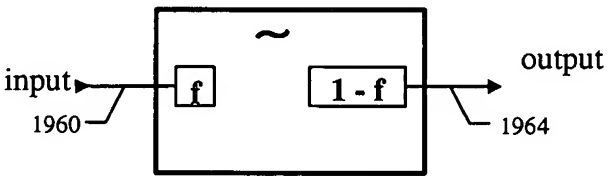

Figure 19c

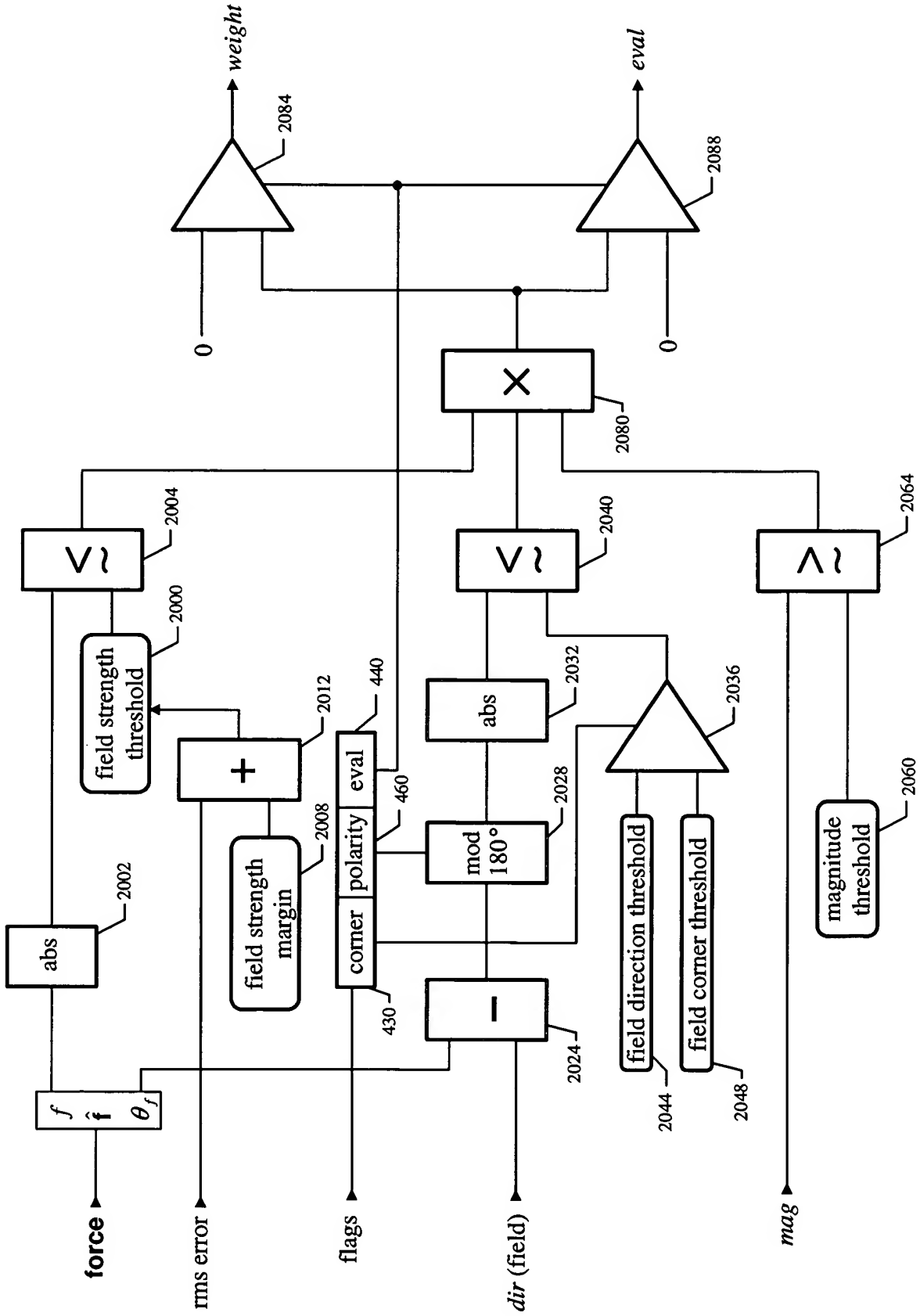
weight
eval
2084
2088
0
0
×
2080
2004
2040
2064
2000
2012
2032
2036
2008
2028
2060
2002
2024
2044
2048
field strength threshold
+
abs
mod 180°
field direction threshold
field corner threshold
magnitude threshold
field strength margin
corner
polarity
eval
440
460
430
abs
−
force
rms error
flags
dir (field)
mag

Figure 20a

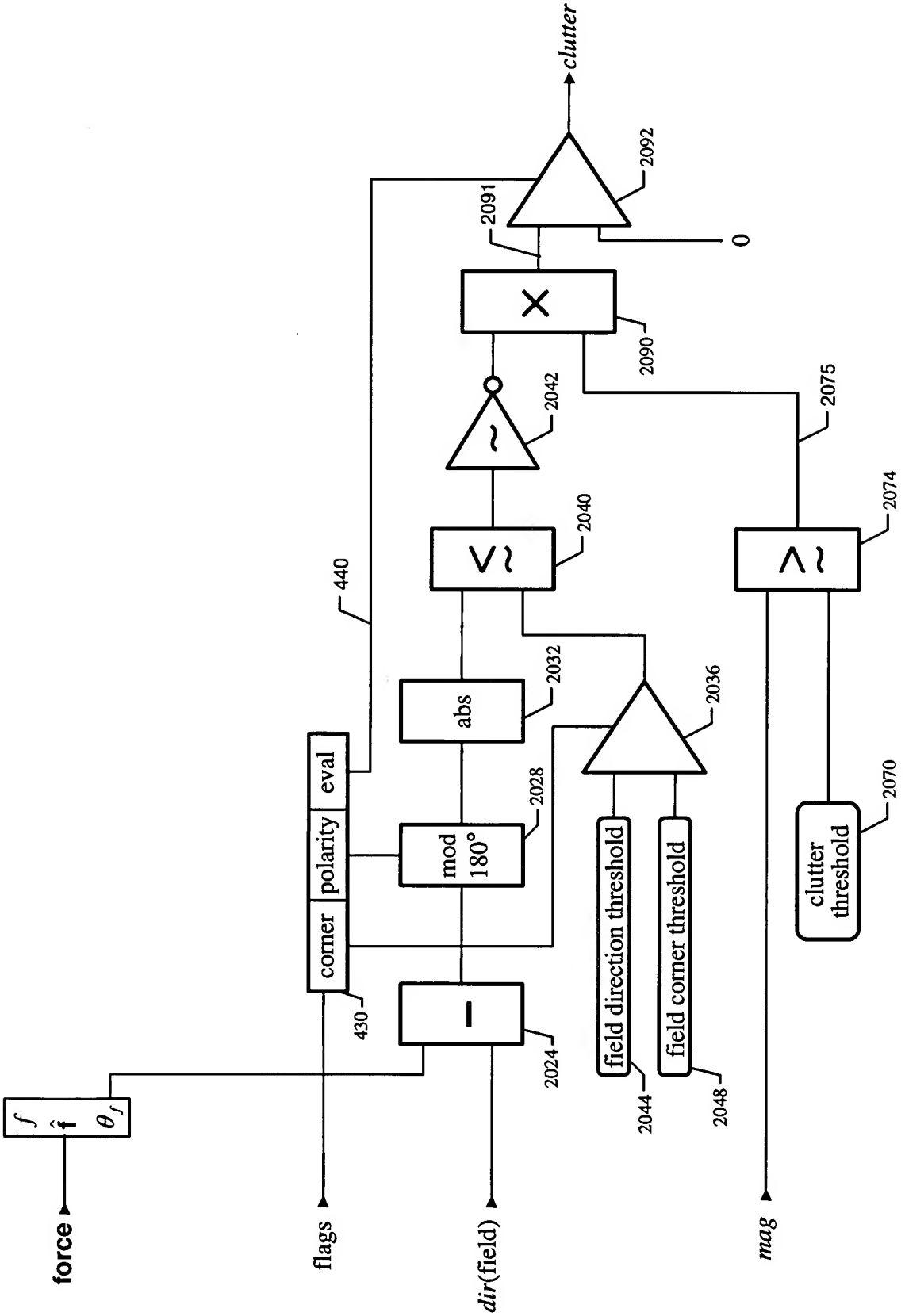
clutter
2092
2091
0
X
2090
2042
2075
2040
2074
440
2032
2036
abs
eval
polarity
corner
mod 180°
2028
field direction threshold
field corner threshold
clutter threshold
2070
430
2024
2044
2048
force
flags
dir(field)
mag

Figure 20b

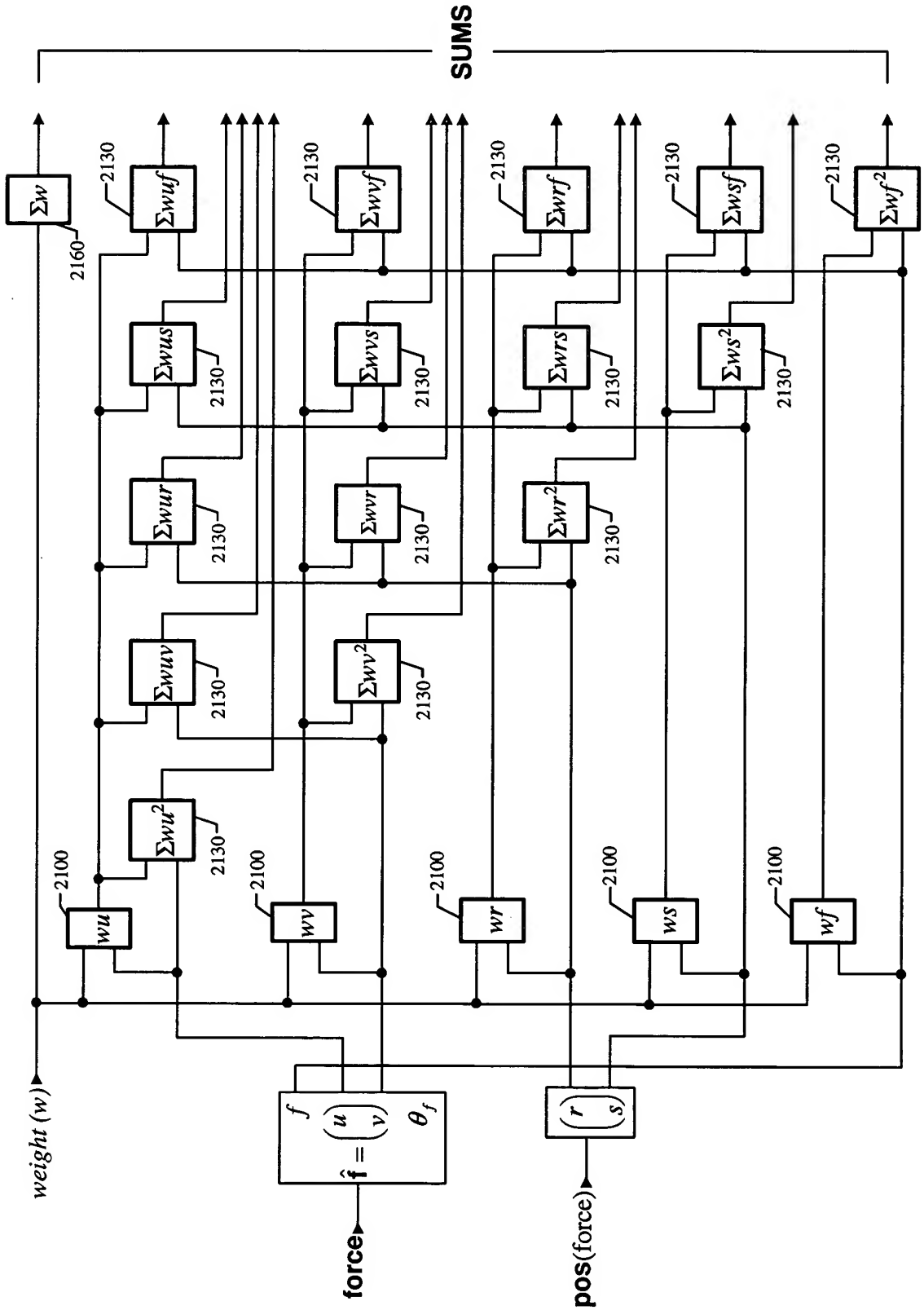
SUMS
Σw
2160
Σwuf
Σwvf
Σwrf
Σwsf
Σwf²
Σwus
Σwvs
Σwrs
Σws²
Σwur
Σwvr
Σwr²
Σwuv
Σwv²
Σwu²
2130
wu
wv
wr
ws
wf
2100
weight (w)
force
pos(force)

Figure 21

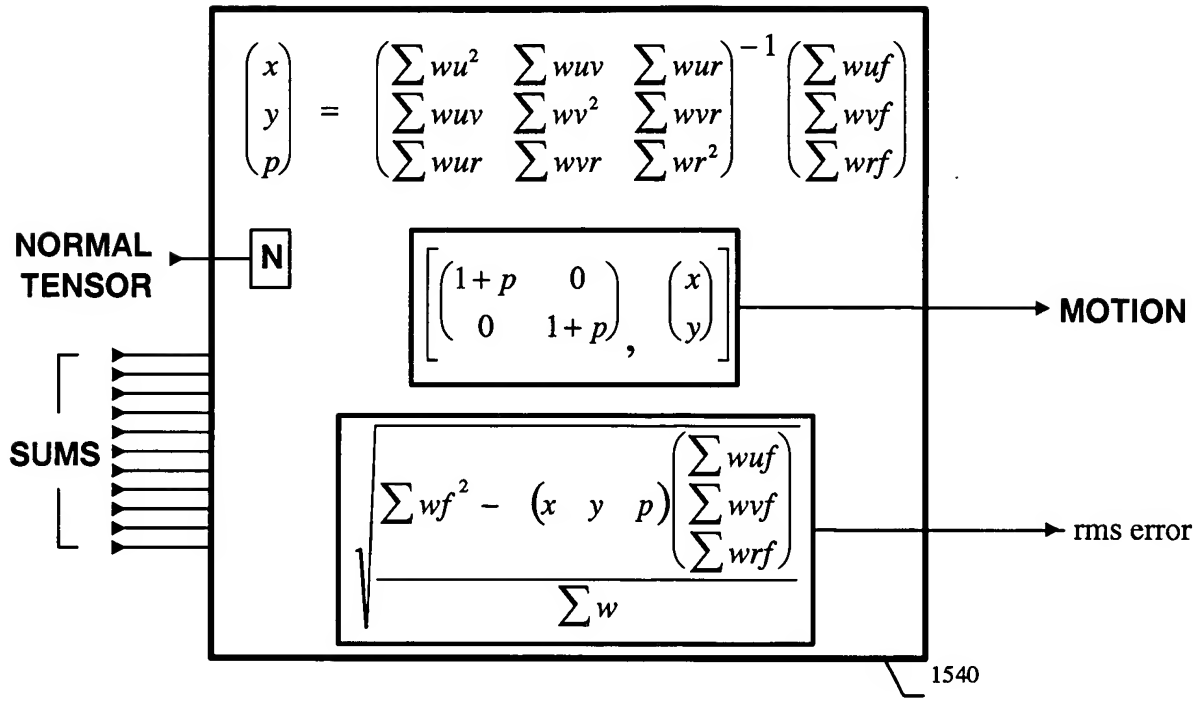

Figure 22c

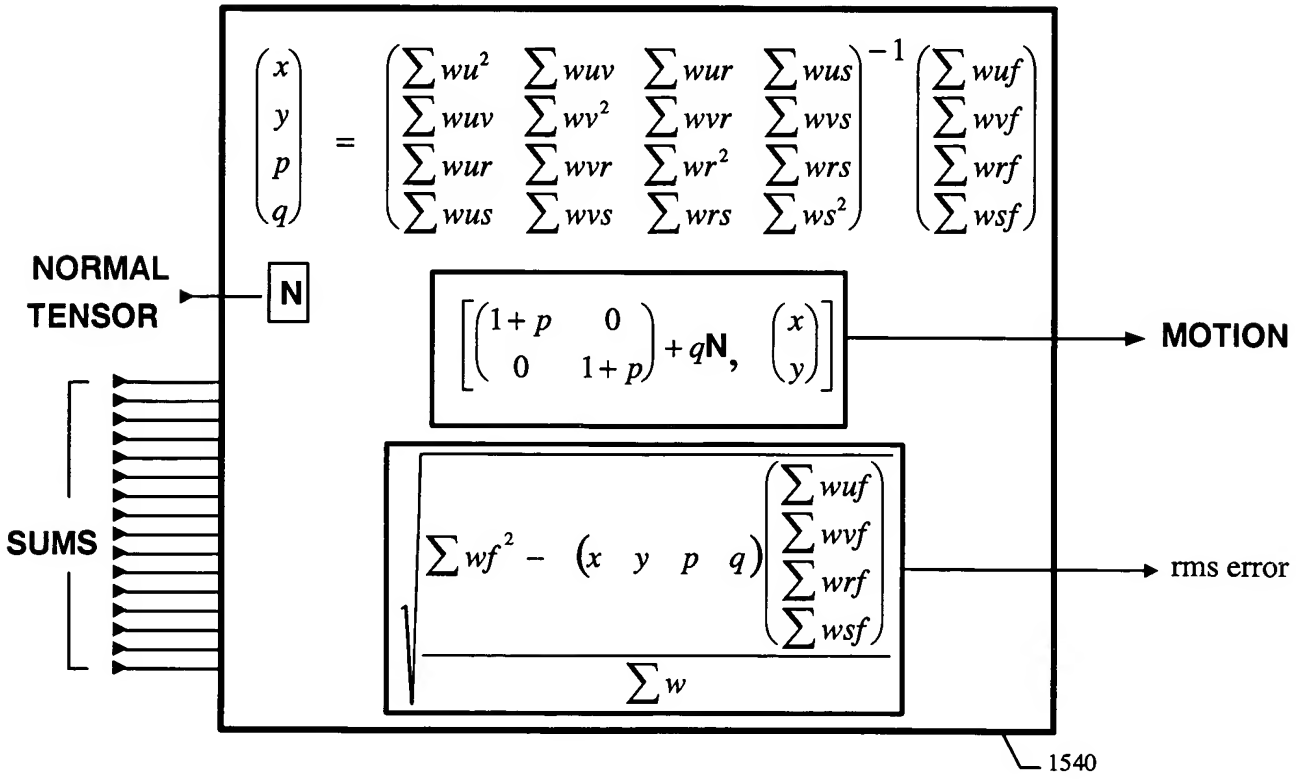

Figure 22d

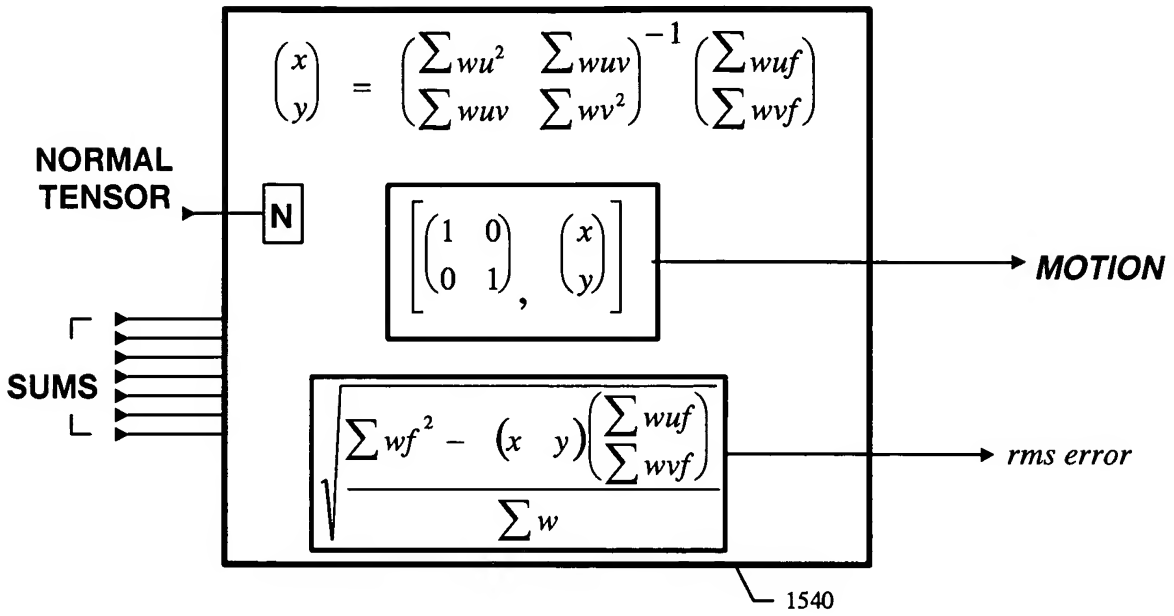

Figure 22a

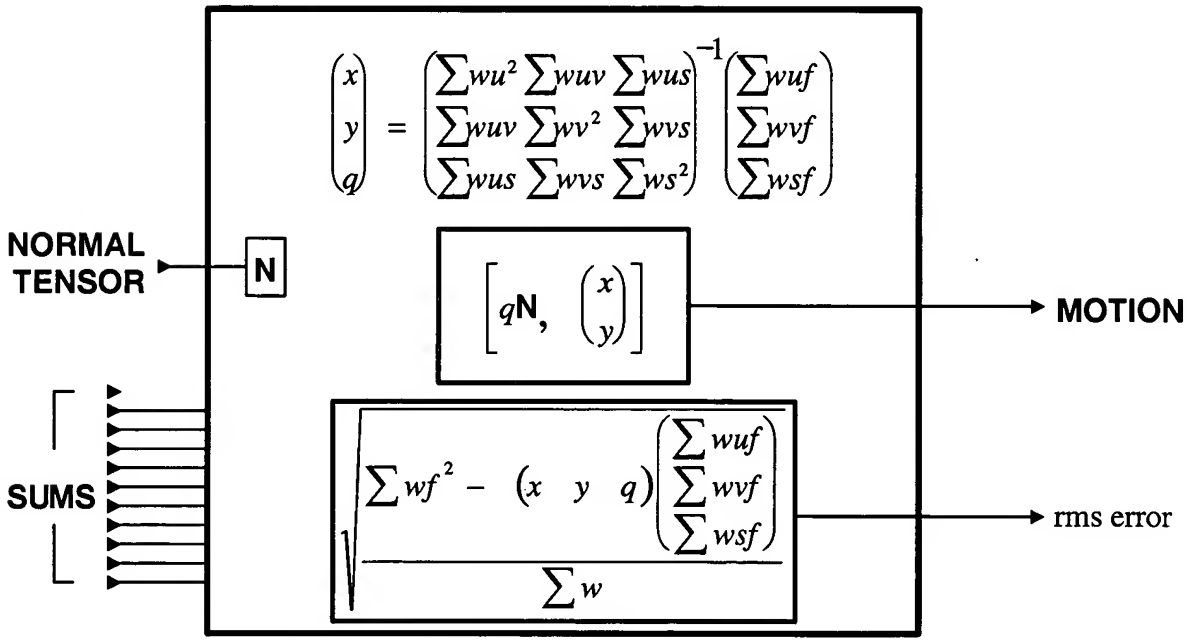

Figure 22b

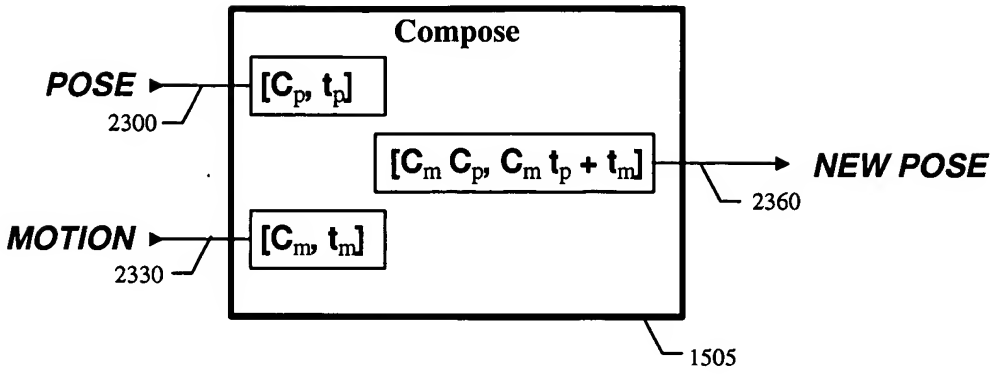

Figure 23

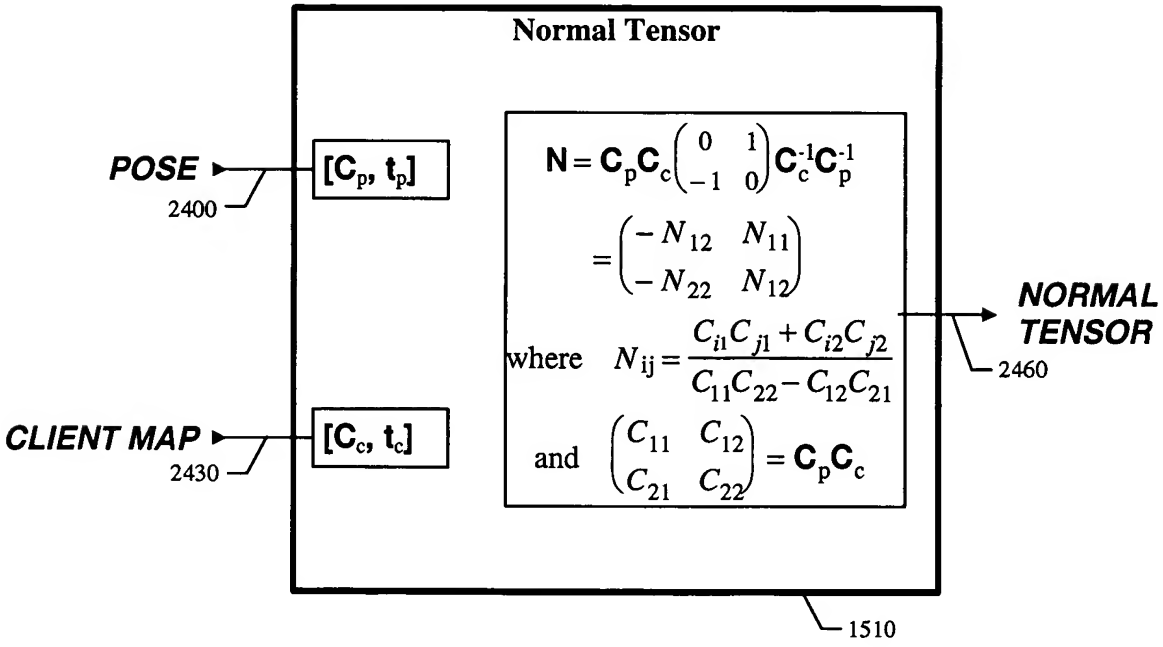

Figure 24

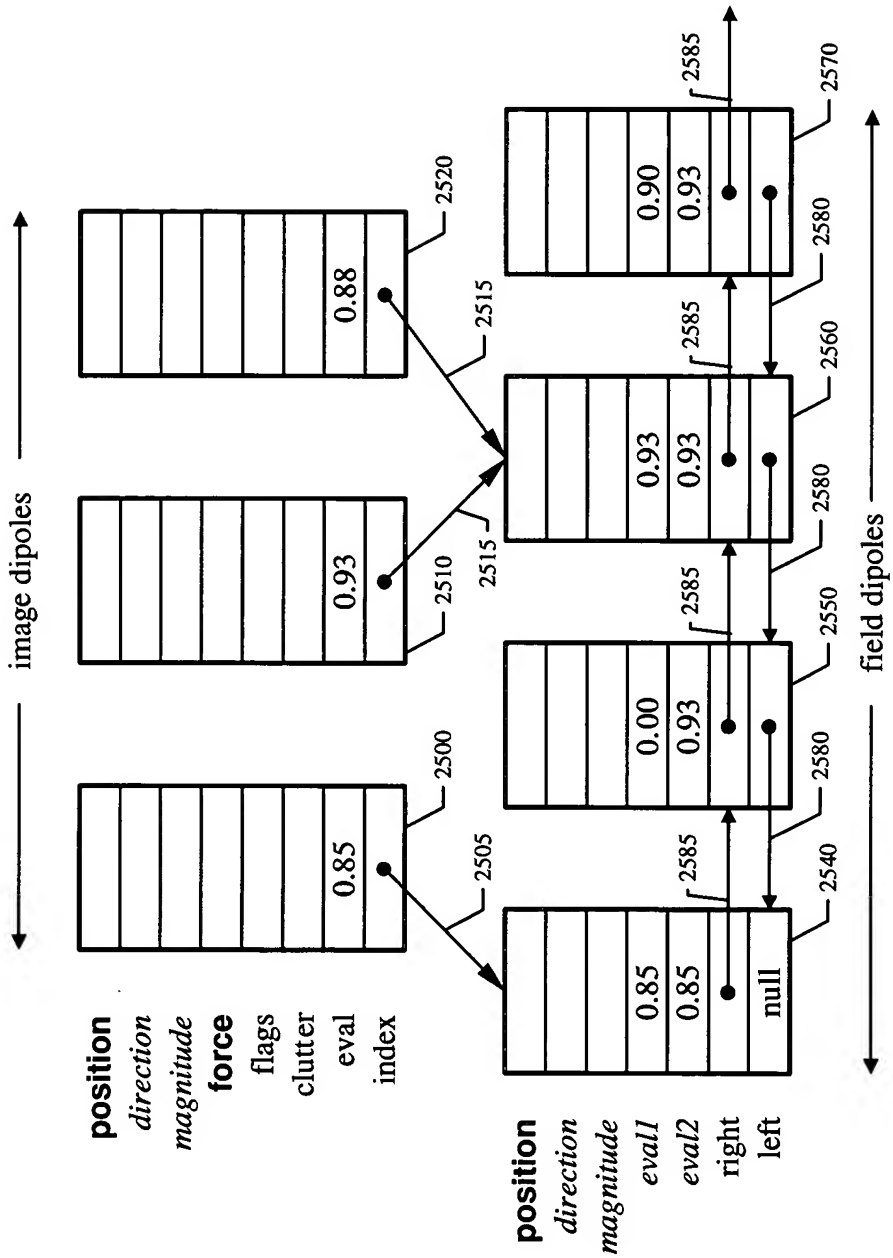
image dipoles
field dipoles
position
direction
magnitude
force
flags
clutter
eval
index
0.85
0.93
0.88
2500
2505
2510
2515
2520
position
direction
magnitude
eval1
eval2
right
left
0.85
0.85
null
0.00
0.93
0.93
0.93
0.90
2540
2550
2560
2570
2580
2585

Figure 25

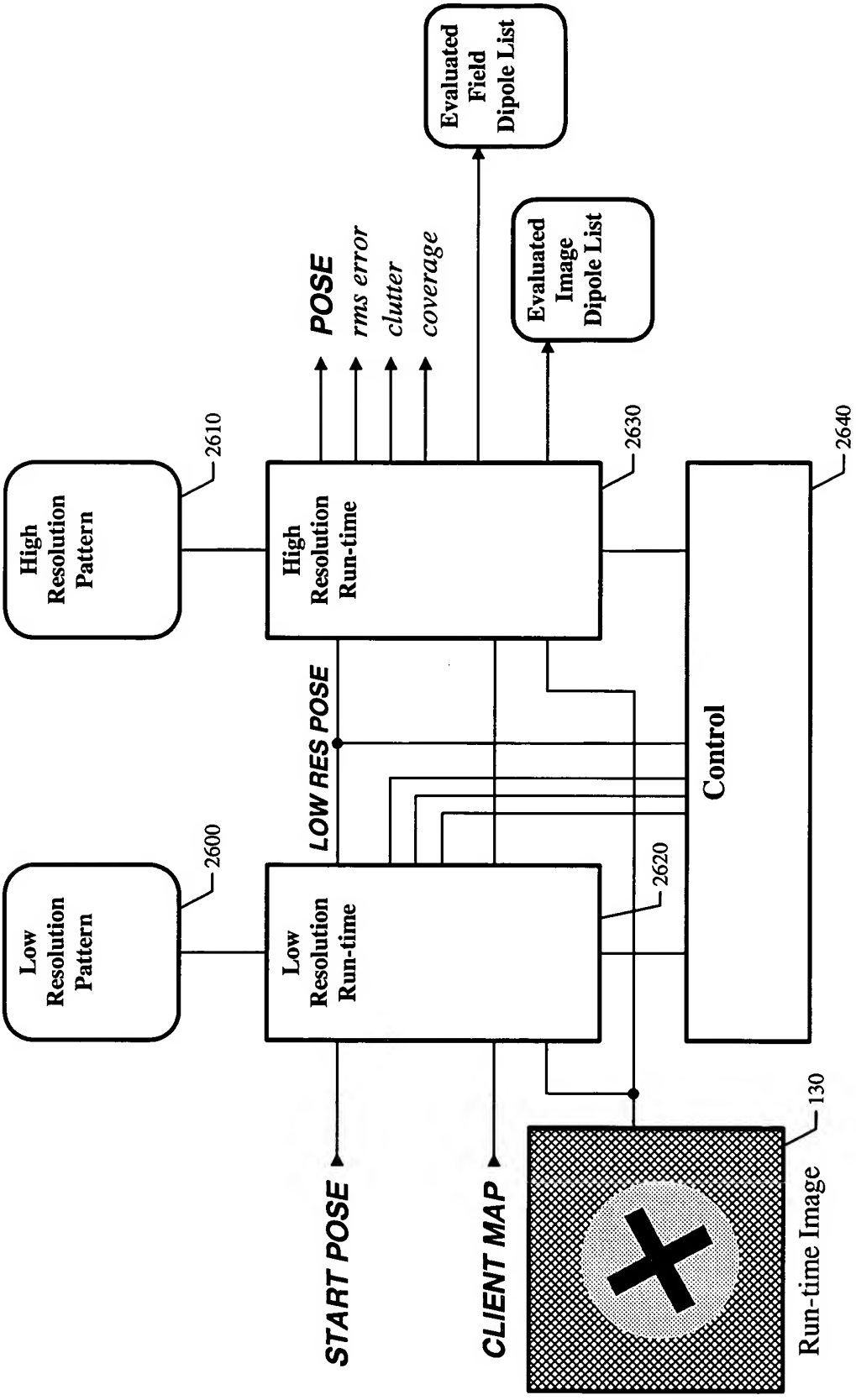
Evaluated Field Dipole List
Evaluated Image Dipole List
POSE
rms error
clutter
coverage
2610
High Resolution Pattern
High Resolution Run-time
2630
2640
Control
LOW RES POSE
2600
Low Resolution Pattern
Low Resolution Run-time
2620
START POSE
CLIENT MAP
130
Run-time Image

Figure 26

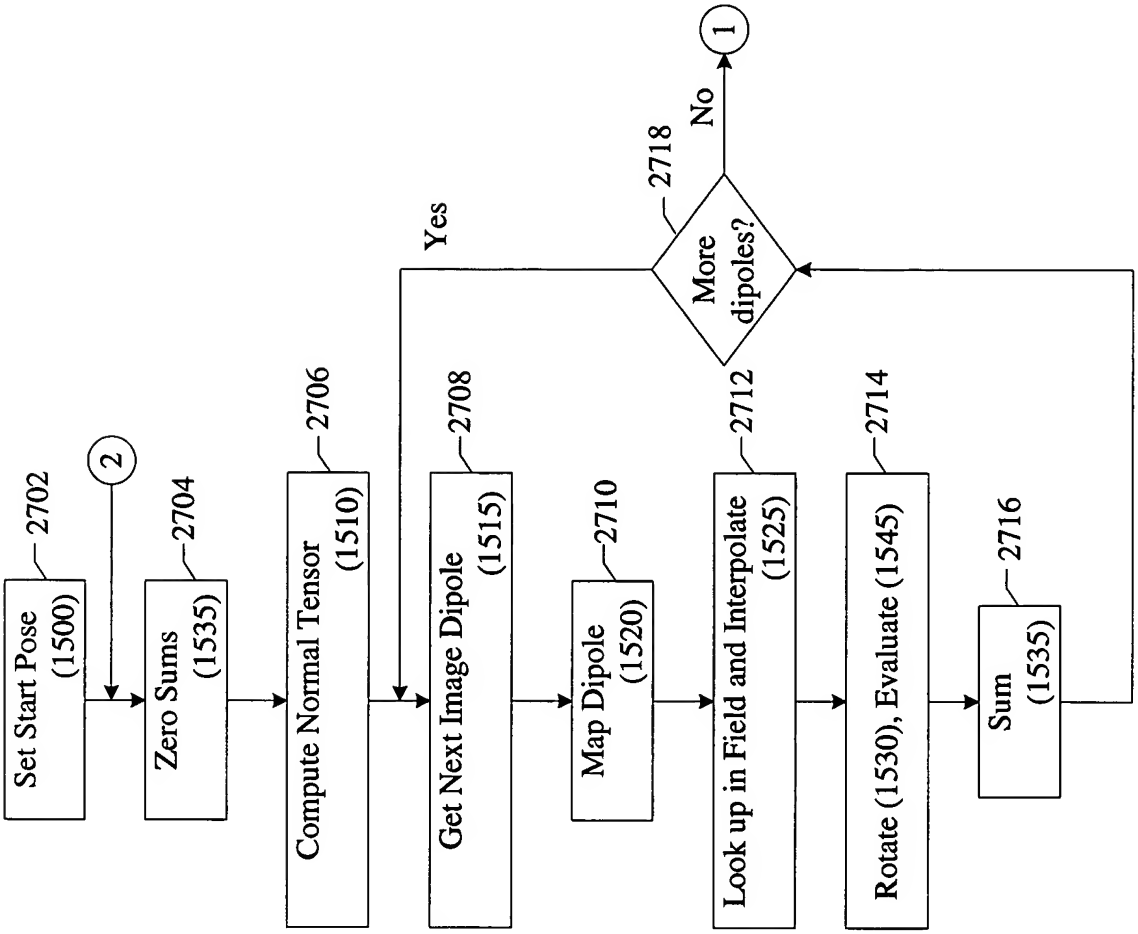
Set Start Pose (1500)
2702
2
Zero Sums (1535)
2704
Compute Normal Tensor (1510)
2706
Get Next Image Dipole (1515)
2708
Map Dipole (1520)
2710
Look up in Field and Interpolate (1525)
2712
Rotate (1530), Evaluate (1545)
2714
Sum (1535)
2716
More dipoles?
2718
Yes
No
1

Figure 27a

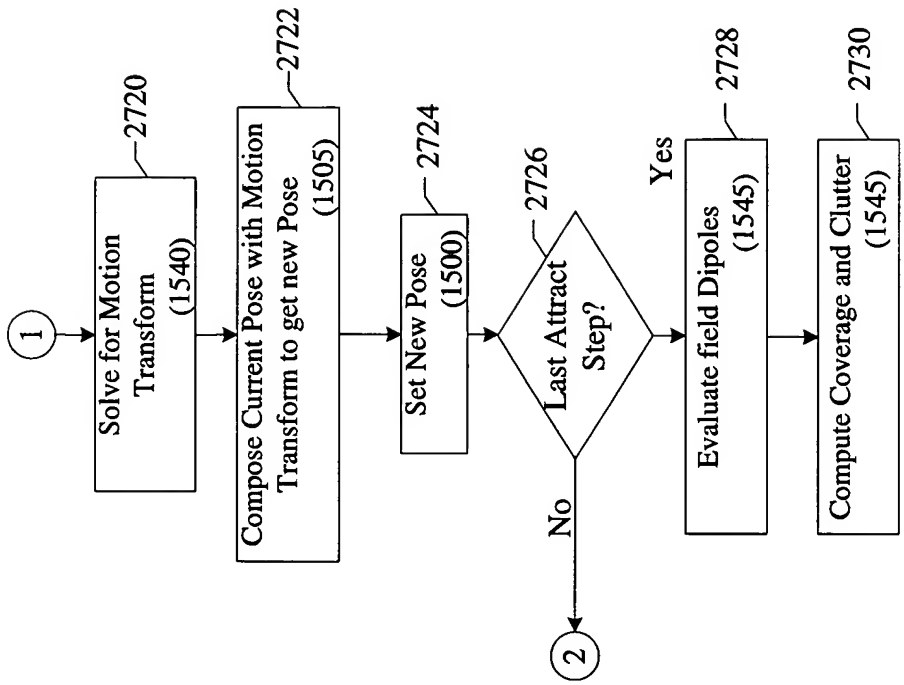
1
Solve for Motion Transform (1540)
2720
Compose Current Pose with Motion Transform to get new Pose (1505)
2722
Set New Pose (1500)
2724
Last Attract Step?
2726
No
2
Yes
Evaluate field Dipoles (1545)
2728
Compute Coverage and Clutter (1545)
2730

Figure 27b

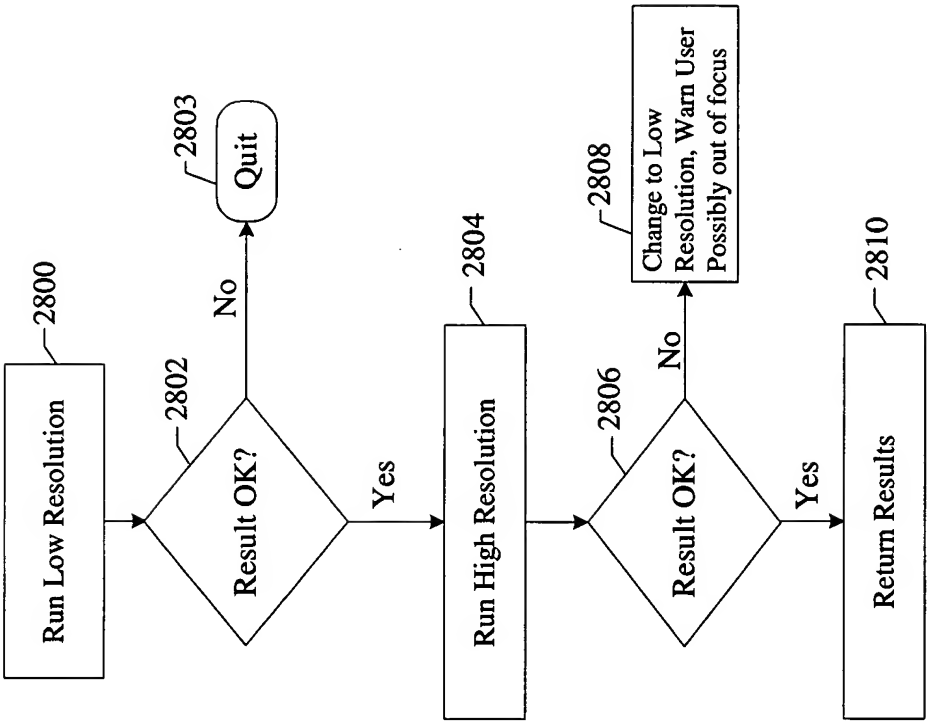
2800
Run Low Resolution
2802
Result OK?
No
2803
Quit
Yes
2804
Run High Resolution
2806
Result OK?
No
2808
Change to Low Resolution, Warn User Possibly out of focus
Yes
2810
Return Results

Figure 28